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A NEW SPECIES OF *MENTZELIA* (LOASACEAE) FROM MONO COUNTY, CALIFORNIA

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Abstract

A new species **Mentzelia monoensis** Brokaw and Hufford, endemic to Mono County, California, is described. **Mentzelia monoensis**, a hexaploid, is most similar to two widespread species, *M. montana* (Davidson) Davidson (tetraploid) and *M. albicaulis* (Douglas ex Hook.) Douglas ex Torr. & A. Gray (octoploid). The three species can be distinguished based on differences in floral bracts, fruits, and seeds. **Mentzelia monoensis** is commonly found in volcanic soils derived from the eruptions of Mono Craters and may exhibit edaphic specializations that limit its distribution.

Key Words: endemic, *Mentzelia*, Mono Craters, polyploidy, systematics.

Mentzelia L. section *Trachyphytum* Torr. & A. Gray (Loasaceae) is a monophyletic group of at least 22 species of annual plants occurring primarily in the western United States with greatest taxon richness in California (Darlington 1934; Zavortink 1966; Hufford et al. 2003; Brokaw and Hufford 2010a, b). The group is taxonomically difficult because of overlapping morphological variation among polyploid species (Zavortink 1966; Brokaw and Hufford 2010b). In her revision of the section, Zavortink (1966) noted a single hexaploid population in Mono County, California, which she dubbed "M. monoensis" but never validly published. In addition to the rarity of specimens available for study, confusion regarding the status of "M. monoensis" has been exacerbated by its similarity to other species in the section. However, recent molecular investigations (Brokaw and Hufford 2010b) have suggested a unique hybrid origin of "M. monoensis" and stimulated a deeper investigation of its form and distribution. That study indicated "M. monoensis" is morphologically distinct from other species of section *Trachyphytum* and endemic to Mono Co., California, where it is distributed throughout the Mono Craters region. In this paper, we describe "M. monoensis" as a new species of *Mentzelia*.

Materials and Methods

During this study, we made field observations and inspected herbarium specimens of all North American species of *Mentzelia* section *Trachyphytum*. Zavortink (1966) based her original recommendation for recognition of 'M. monoensis' on specimens from the collection *Zavortink 2640* and chromosome counts from squashes of microsporocytes from the same population. We have located and included fifteen additional population of 'M. monoensis' in morphological comparisons with herbarium specimens, including an isotype (UC68802, *Hall 6577*), of *M. montana* (Davidson) Davidson. Morphological measurements were taken with digital calipers, using a dissecting microscope when necessary. Seed surface characters were assessed using scanning electron microscopy (SEM). Seeds of "M. monoensis" obtained from the herbarium specimens WS376107 (*Zavortink 2640*) and WS375796 (*Brokaw 368*), and seeds of *M. montana* from the herbarium specimens LA100619 (*Zavortink 2586*) and WS367986 (*Brokaw 72*), were mounted on metal stubs and coated in gold prior to imaging. Seeds were examined at 12 kV using a Hitachi S-570 scanning electron microscope and micrographs were made at 70×, 80×, and 750×. Locality data for populations were gathered during fieldwork and from herbarium specimens. Latitude and longitude or UTM coordinates for new collections were made in the field using GPS (WGS 84 map datum).

Taxonomy

Mentzelia monoensis J. M. Brokaw & L. Hufford, sp. nov. (Fig. 1). —TYPE: USA, California, Mono Co., along State Hwy 120, 8 mi E of U.S. 395, 16 June 2007, *J. M. Brokaw 367* (holotype: WS; isotypes: NY, UC, US).

Herba annua, 10–30 cm alta, erecta. Inflorescentia cymis; bractea integra viridia rarior basis albus. Calyx connatus, sepala 5, subulatus.

FIG. 1. Type specimen of *Mentzelia monoensis*. Scale bar = 10 cm.

Apopetalus, petala 5, usque 4.1 mm longa, apex luteus et basis aurantiacus. Stamina 10–30, usque 3 mm longa. Ovarium inferum, placentae 3 parietalibus; stylus usque 3.3 mm longa. Fructus capsularis, Seminum numerosus, testa colliculate.

Annual herbs, 10–30 cm tall; taprooted. Shoots densely pubescent throughout (except as noted) with both needle-like and glochidiate trichomes; needle-like trichomes with pointed apex and erect barbs arranged in many whorls along the needle shaft; glochidiate trichomes usually with apical and several other whorls of recurved barbs along the stalk. Stem erect; axillary branches ascending, straight to curved upward; stem epidermis light tan to salmon-colored, moderately pubescent. Leaves alternate, pubescent with greater density of trichomes on abaxial surface, trichomes needle-like and glochidiate; needle-like trichomes often with pustulose bases; basal rosette leaves 2.1–86 × 0.3–10 mm, linear, all sessile or some appearing petiolate due to narrowed lamina at base, often not persisting to maturity, margins entire to 12-lobed on distal half, lobes nearly opposite, regular, 1.0–3.8 mm long with rounded apices; lower cauline leaves 6.2–55 × 2.0–7.9 mm, linear to lanceolate, sessile to appearing petiolate, margins entire to 12-lobed on distal half, lobes nearly opposite, regular, 0.5–3.5 mm long with rounded to acute apices; upper cauline leaves up to 34.2 × 8.5 mm, linear to ovate, sessile to clasping, margins usually entire. Inflorescence cymose, bract subtending inferior ovary 1.5–4.5 × 0.4–2.3 mm, entire, green (rarely with inconspicuously white base). Flowers epigynous; bearing a hypanthium at the distal end of the ovary on which the calyx, corolla, and androecium are inserted. Calyx basally connate, five triangular lobes, lobes 1.9–3.1 × 0.8–1.1 mm, apices acute to attenuate, margins entire, pubescent; trichomes like those of leaves. Petals five, distinct, 2.1–4.1 × 1.9–3.1 mm, obovate, with yellow apex and orange base, glabrous, apex retuse to rounded with several trichomes at midvein; trichomes with erect barbs arranged in many whorls, apex needle-like, base not pustulose. Androecium yellow; stamens ca. 10–30, ca. 2–3 mm, those of inner whorls shorter than outer whorls; filaments all filiform. glabrous; anther epidermis papillate. Gynoecium 3-carpellate; ovaries inferior, placentae 3, parietal; styles 2.2–3.3 mm long, glabrous; stigmas three, lobes appressed, papillate. Fruit a capsule, 6–15 × 2–3 mm, cylindrical to clavate and tapering near base, erect to curved less than 20°, opening apically, usually without prominent longitudinal ribs, pubescent; trichomes like those of leaves. Seeds ca. 1 × 1 mm, ca. 5–30 per capsule, in more than one row above mid-fruit; seeds above mid-fruit irregular-rounded; seeds below mid-fruit occasionally trigonal prisms with grooves along longitudinal edges; seed coat tan, colliculate under 10× magnification, domes less than 1/2 as tall as wide; seed coat cells 25–75 μm wide (smaller near hilum), with straight anticlinal walls.

Chromosome number: $2n = 54$ (Zavortink 1966).

Phenology: *Mentzelia monoensis* begins flowering at lowest elevations in late May and continues through late July. Plants bearing both flowers and ripe capsules with mature seeds are most common in early to middle July. By early August, most plants have senesced and quickly disintegrate.

Etymology: This species is named for the Mono Craters region and Mono Co., California, to which it appears to be endemic. We suggest the common name Mono Craters blazingstar.

Distribution: Populations of *M. monoensis* occur primarily on course pumice soils and disturbed sites near the Mono Craters of Mono Co., California, at 2008–2482 m elevation. They are associated especially with antelope bitterbrush and Jeffrey pine communities and barren pumice slopes.

Representative specimens. USA. CALIFORNIA. **Mono Co.**: Mono Craters, along State Hwy 120 about 8 mi. E of U.S. Hwy 395, *Thompson 1696* (LA); along State 120, 8 mi. E of U.S. 395, *J. Zavortink 2640* (RSA, WS); CA State Hwy 120 N of Mono Mills in barren pumice valley, UTM 11S 4197240mN 325071mE, *Brokaw 368* (ACU, WS); CA State Hwy 120 NE of Crater Mountain, UTM 11S 4197256mN 325051mE, *Brokaw 519* (WS); on North Crater S of Mono Lake, UTM 11S 4199798mN 319945mE, *Brokaw 520* (WS); in the East Craters Sand Flat, S of Crater Mountain and E of Punch Bowl, 37.82022°N, 119.00142°W, *Brokaw 547* (ACU, WS); along CA State Hwy 120 W of its junction with Sage Hen Meadows Rd, 37.89023°N, 118.86738°W, *Brokaw 554* (ACU, WS); at the junction of U.S. Hwy 395 and CA State Hwy 120, 37.88666°N, 119.09028°W, *Brokaw 558* (ACU, WS); E of U.S. Hwy 395 S of its junction with West Portal Rd, 37.86439°N, 119.08492°W, *Brokaw 559* (ACU, WS); along CA State Hwy 120 SW of Granite Mountain, 37.89059°N, 118.78930°W, *Brokaw 560* (ACU, WS); along CA State Hwy 120 E of Granite Mountain near its junction with Dobie Meadows Rd (Rd 3027), 37.92131°N, 118.70541°W, *Brokaw 561* (ACU, WS); along CA State Hwy 120 E of Granite Mountain N of Indian Meadows, 37.91792°N, 118.71134°W, *Brokaw 562* (ACU, WS); E of Lake Crowley along Benton Crossing Rd N of Round Mountain, 37.63795°N, 118.63873°W, *Brokaw 566* (ACU, WS); along West Portal Rd E of U.S. Hwy 395, 37.84638°N, 119.06704°W, *Brokaw 571* (WS); along West Portal Rd E of U.S. Hwy 395, 37.84789°N, 119.06490°W, *Brokaw 572* (ACU, WS); along CA State Hwy 167 at Wilson Creek,

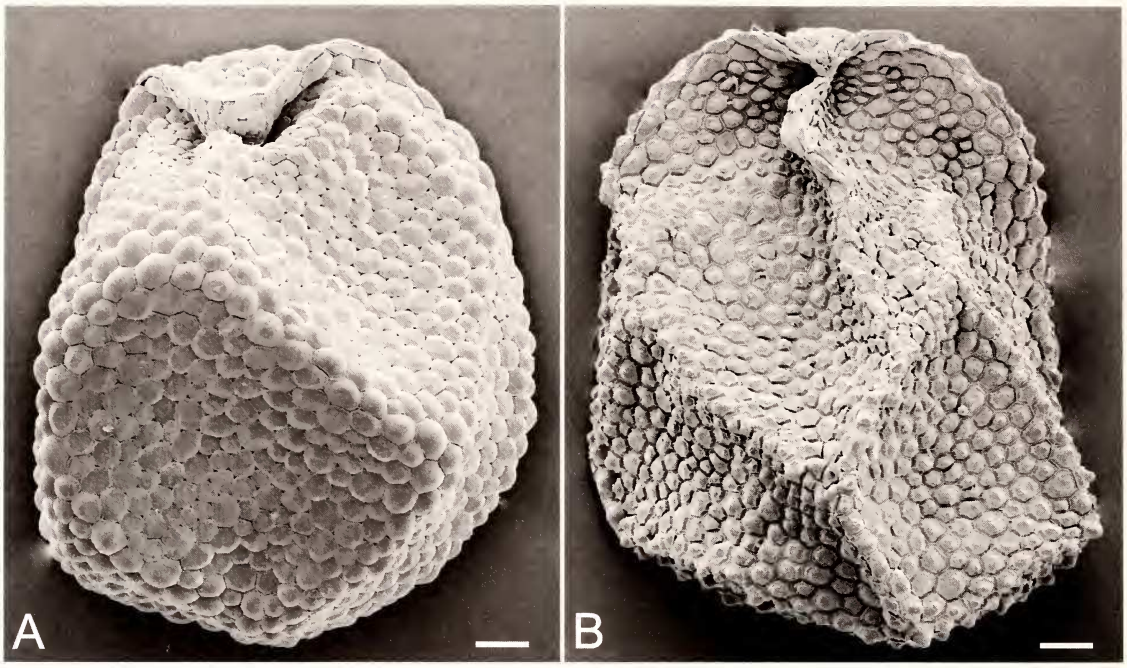

FIG. 2. Scanning electron micrographs showing variation in seed coat cell shape in: A. *Mentzelia monoensis* and B. *M. montana*. Scale bars = 100 μm.

38.05379°N, 119.12708°W, *Brokaw 573* (ACU, WS).

DISCUSSION

Recent phylogenetic analyses suggest that *M. monoensis* has a unique allopolyploid origin (Brokaw and Hufford 2010b). *Mentzelia* section *Trachyphytum* is composed of two major clades, "Affines" and "Trachyphyta" (Zavortink 1966; Brokaw and Hufford 2010a). Most polyploid species in *Trachyphytum* appear to be allopolyploids derived from hybridizations within the "Trachyphyta" clade (Zavortink 1966; Brokaw and Hufford 2010b). The only exceptions are *M. dispersa* S. Watson of the "Affines" clade, which may be an autopolyploid complex, and *M. monoensis*, the only species exhibiting substantial genetic signal from both major clades (Brokaw and Hufford 2010b). One hypothesis of origin consistent with the molecular data is that *M. monoensis* was derived through allopolyploidization involving a diploid progenitor closely related to *M. dispersa* and a tetraploid progenitor closely related to *M. montana* (Brokaw and Hufford 2010b). Both *M. dispersa* and *M. montana* occur in the Mono Craters region.

Mentzelia montana and *M. congesta* Torr. & A. Gray (diploid) are the only species in section *Trachyphytum* that have been found to co-occur with *M. monoensis*, though *M. laevicaulis* (Douglas ex Hook.) Torr. & A. Gray of section *Bartonia* Torr. & A. Gray has also been observed in proximity. Co-occurrence with *M. montana* is of particular concern because some populations of *M. monoensis* and *M. montana* can only be distinguished with difficulty. The bracts of *M. monoensis* are always entire and usually fully green, and those of *M. montana* are usually lobed with a white base. However, both species may exhibit entire floral bracts with whitish bases, though the white is more prominent in *M. montana*. In sympatric populations the grayish-green hue in leaves of *M. monoensis* may be also be apparent compared to the lighter green in leaves of *M. montana*. The two species can be most reliably distinguished when mature seeds are compared under 10–20× magnification. *Mentzelia monoensis* has a tan colored seed coat composed of cells that are rounded, appearing as shallow domes (Fig. 2A). In contrast, *M. montana* has a mottled seed coat with cells that stand out as rough, pointed knobs along edges of the seed (Fig. 2B).

Likewise, despite superficial similarity of the plants, the seeds of *M. monoensis* can be distinguished from those of *M. albicaulis* (Douglas ex Hook.) Douglas ex Torr. & A. Gray (octoploid), which also have a mottled seed coat but have cells that project from the surface to an even greater extent than those of *M. montana*, giving a distinctly rough appearance to the seeds. The bracts of *M. albicaulis* exhibit approximately the same range of form and color found in *M. monoensis*. However, *M. albicaulis* is distinct from both *M. monoensis* and *M. montana* in its

FIG. 3. Habit of *Mentzelia monoensis*. East Craters Sand Flat, Mono Co., California.

fruit shapes and distribution. Unlike the short, erect fruits of *M. monoensis* and *M. montana*, mature specimens of *M. albicaulis* usually have at least some long, recurved fruits greater than 15 mm and curved between 90° and 180°. In Mono Co. both *M. monoensis* and *M. montana* occur above 2000 m, and *M. albicaulis* occurs below 2000 m.

Like *M. monoensis*, *M. nitens* Greene has entire, green bracts and shallowly domed seed coat cells. However, like *M. albicaulis*, it has long, curved fruits and only occurs below 2000 m. *Mentzelia nitens* is distinguished from other species from section *Trachyphytum* in Mono Co. by its large petals (≥ 8 mm).

The only hexaploid species of *Mentzelia* in northeastern California other than *M. monoensis* is *M. veatchiana* Kellogg. *Mentzelia veatchiana* is more robust than *M. monoensis* with larger flowers (styles > 3.5 mm) and lobed bracts. Further, many populations of *M. veatchiana* exhibit orange petals with red bases, unlike *M. monoensis* and all other species in *Trachyphytum* that occur in eastern California.

Despite the difficulty of identifying some populations of *M. monoensis*, this species is an

important endemic component of the Mono Craters flora. Although often difficult to distinguish morphologically, unrecognized polyploid species may result in substantial underestimates of diversity (Soltis et al. 2007). For example, recently published floras have lumped diploid, tetraploid, hexaploid, and octoploid cytotypes as the single taxon, *M. albicaulis* (Holmgren et al. 2005), and no morphological characters to distinguish diploid, tetraploid, and octoploid cytotypes of *M. dispersa* have been identified (Brokaw and Hufford 2010a).

The occurrence *M. monoensis* in a region largely composed of volcanic substrates suggests that the establishment of populations after polyploidization may have been associated with new edaphic specializations. *Mentzelia monoensis* has been found in habitats ranging from pumice soils and gravels in open barrens, *Purshia* scrub, and pine forests (Fig. 3) to disturbed sites along roadsides. Similar to other species in *Mentzelia* (Prigge 1986), *M. monoensis* appears to avoid competition in productive communities through colonization of disturbed and/or stressful habitats. Further investigation of possible substrate specificity is needed in order to better understand the function of *M. monoensis* in the Mono Craters plant communities.

Identification Key for *Mentzelia* Section *Trachyphytum* in Mono County, California

1. Seeds in one row above mid-fruit, all trigonal prisms with grooves along longitudinal edges . . . . *M. dispersa*
1′ Seeds in more than one row above mid-fruit; seeds above mid-fruit irregular-rounded to -angular, seeds below mid-fruit occasionally trigonal prisms with grooves along longitudinal edges
    2. Floral bracts usually entire, green only
        3. Petals greater than or equal to 8 mm . . . . . *M. nitens*
        3′ Petals less than 8 mm
            4. Longest mature fruits usually greater than 15 mm, curved less than 180°; seeds tan and moderate- to dense-mottled brown to black in age; seed coat cells pointed or domed, in age greater than 1/2 tall as wide on seed surface edges; below 2000 m . . . . . *M. albicaulis* (in part)
            4′ Longest mature fruits less than 15 mm, curved less than 20°; seeds tan, not or sparse-mottled in age; seed coat cells flat-surfaced to domed, in age less than 1/2 tall as wide on seed surface edges; 2000–2500 m . . . . . *M. monoensis* (in part)
    2′ Floral bracts toothed to lobed or floral bracts entire with white base and green margin
        5. Floral bracts conspicuous, concealing fruits, mostly white with green fringe . . . . . *M. congesta*
        5′ Floral bracts not conspicuous, not concealing fruits, entirely green or mostly green with white below middle only
            6. Petals with orange to yellow apex and red to orange base; styles greater than or equal to 3.5 mm; longest mature fruits usually greater than 15 mm. . . . . *M. veatchiana*
            6′ Petals with yellow apex and orange base; styles less than 3.5 mm; longest mature fruits usually greater than 10 mm
                7. Floral bracts 3-lobed to entire; longest mature fruits usually greater than 15 mm, usually curved less than 180°; below 2000 m . . . . . *M. albicaulis* (in part)
                7′ Floral bracts 7-lobed to entire; longest mature fruits usually less than 15 mm, curved less than 45°; above 2000 m
                    8. Floral bracts 7-lobed to entire, white base usually conspicuous; seeds tan and moderate- to dense-mottled brown to black in age; seed coat cells pointed, in age some greater than 1/2 tall as wide on seed surface edges; above 2000 m . . . *M. montana*
                    8′ Floral bracts entire, white base inconspicuous; seeds tan, not or sparse-mottled in age; seed coat cells flat-surfaced to domed, in age less than 1/2 tall as wide on seed surface edges; 2000–2500 m . . . . . *M. monoensis* (in part)

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